DSN Ground Communications Facility

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The Ground Communications Facility has been designed to provide reliable Earth-based, point-to-point voice and data communications as part of the DSN Tracking and Data Acquisition System.

I. Introduction

The Ground Communications Facility (GCF) is one of the three functional elements of the Deep Space Network and provides the capability required for the transmission, reception, and monitoring of voice and data communications between the various locations of the DSN. The GCF uses common carrier circuits engineered by the NASA Communications (NASCOM) Division of the Goddard Space Flight Center, interconnected to specialized switching, terminal, and monitor equipment, integrated into a world-wide system, and operated in support of space flight missions. The GCF is composed of five subsystems: Teletype, Voice, High-Speed, Wideband, and Monitor. The Office of Tracking and Data Acquisition of the Jet Propulsion Laboratory provides the technical direction and systems management of the GCF and acts as the representative of NASCOM for communications switching functions on the west coast.

II. GCF–NASCOM Interrelationships

The interrelationships at the programmatic level between the Jet Propulsion Laboratory-developed Ground Communications Facility and the Goddard Space Flight Center NASCOM are characterized as follows:

(1) NASCOM

- (a) Provides ground communications of all operational data for all NASA missions, including those supported by the DSN.
- (b) Accepts and supports communications requirements established by the DSN.
- (c) Establishes basic characteristics of NASA operational ground communications subsystems, such as teletype line rate, high-speed block size, and wideband circuit capability.

(2) GCF

- (a) Provides ground communications for all DSN missions using the services of NASCOM.
- (b) Establishes additional characteristics of all GCF subsystems, such as block multiplexing and error correction.

III. Objectives and Goals

The GCF design is based on standardized communication techniques to provide more efficient transmission of user data and simple user and NASCOM interfaces. These objectives are met by:

(1) Providing message switching and routing.

(2) Transmitting data which are essentially transparent, i.e., user data are accepted and delivered in established formats and without additional errors.

(3) Minimizing project-dependent equipment within the GCF.

(4) Providing centralized data records.

The continuing goals of the GCF are to provide highly reliable and cost-effective data transmission while maintaining a capability balance between the DSN and users, and include:

(1) Equipment and routing redundancy to minimize single-point-of-failure impact.

(2) Error performance which does not degrade data beyond RF-link error performance.

(3) Design coordinated with NASCOM Development Program.

IV. Configuration and Functional Subsystems

The current GCF configuration, including the related NASCOM functions, is shown in Fig. 1. This configuration is functionally organized into High-Speed Data, Wideband Data, Voice, Teletype, and Monitor Subsystems.

A. High-Speed Data Subsystem

The High-Speed Data (HSD) Subsystem consists of assemblies that switch, transmit, receive, record, process, distribute, test, and monitor digital data and is used for the transmission of:

(1) All digital data of the DSN command, tracking, and monitor and control systems.

(2) All low- or medium-rate data of the DSN telemetry system and the DSN test and training system.

(3) All GCF monitor and control data.

The High-Speed Data Subsystem provides a capability for transmitting and receiving serial bit stream formatted data over four-wire circuits having a 3.0-kHz bandwidth. This serial bit stream is impressed on communication circuits at a continuous line bit rate divided into message segments referred to as high-speed blocks. The two key characteristics are:

(1) Data blocks containing user data bits to be transmitted.

(2) Filler blocks containing filler bits provided by GCF equipment when the user data bit rate is insufficient to maintain the fixed line bit rate required by design specifications.

Each block is divided into three parts: header, text, and ending. Formats for the data blocks and filler blocks are illustrated in Tables 1 and 2.

The current plans are to provide the functional capabilities illustrated in Fig. 2 and to standardize at a 1200-bit message segment and a line bit rate of 7200 b/s. Other planned changes include conversion from a 33-bit to a 22-bit error polynomial and increasing the number of bits reserved in the data block ending from 36 to 40 bits to provide error correction, by re-transmission, for short outages or errors in GCF data transmission. The purpose of these changes is to significantly reduce the error for nonreal-time replay of data. Figure 3 illustrates HSD Subsystem configuration which is planned for the CY 1977 and CY 1978 time period. The two configurations are required to provide continuous project support during the period of conversion from the existing Ground Data System to the new one for support of the Mariner Jupiter–Saturn and Pioneer Venus Projects.

B. Wideband Data Subsystem

The Wideband Data Subsystem consists of assemblies that switch, transmit, receive, process, distribute, test, and monitor data requiring the use of bandwidths greater than those provided by standard high-speed channels. The Wideband Data Subsystem illustrated in Fig. 4 includes standard wideband circuits as well as intersite-microwave capabilities. The Wideband Subsystem is used for:

(1) Telemetry data.

(2) Simulation data.

(3) Test and training data.

(4) Data interchange within the DSN including operational control.

(5) Intrasite communications and timing signals.

The wideband data circuits to the deep space stations contain serial bit streams impressed on communication circuits at a continuous line bit rate typically 27.6, 28.5, 50, 168, or 230.4 kilobits per second divided into 2400- or 4800-bit message segments. Similar to the high-speed data, the message segments or data blocks contain user bits to be transmitted and filler bits provided by the GCF equipment when the user data bit rate is insufficient to maintain the fixed line bit rate required by design specifications. The data blocks are also divided into three parts: head, text, and ending, as illustrated in Tables 3 and 4.

C. Voice Subsystem

The Voice Subsystem consists of assemblies that switch, transmit, receive, distribute, test, and monitor transmissions originally generated in vocal form and includes capabilities between the facilities of the Deep Space Network and to the Mission Control Centers. The functional capabilities and key characteristics include:

(1) Standard voice-data grade circuits for all traffic.

(2) Conferencing capability on one intercontinental circuit during noncritical periods for all deep space stations supporting a single project; individual circuits for each DSS during critical periods, resources permitting.

(3) User-controlled intercom switching.

(4) Circuits used for high-speed data transmission (backup) if required.

(5) Voice traffic recording in the central communications terminal upon request.

D. Teletype Subsystem

This subsystem consists of assemblies that switch, transmit, receive, distribute, test, and monitor digital signals originally generated in Baudot format at a teletype (TTY) rate of 100 words per minute. The operational use of teletype continues to be de-emphasized and is used primarily for emergency, backup operational transmissions and administrative communications. Services and key characteristics include:

(1) Handling Air Force Eastern Test Range (AFETR)-generated predicts for DSN initial acquisiton.

(2) Transmitting non-operational messages between the JPL Message Center and other locations.

(3) Use of standard NASCOM format and the NASCOM communications processor for message switching.

E. Monitor and Control Subsystem

The Monitor and Control Subsystem consists of assemblies that gather, calculate, record, display, and report the operational configurations, status, and performance of the GCF subsystems. A central monitor processor has been designed to receive inputs from other GCF subsystems as necessary to permit internal assessment of performance, problem detection, isolation, and correction.

V. Typical Configuration

The Viking Project represented one of the most extensive users of the GCF because of the two orbiting and two lander spacecraft and extended critical phases of the mission. The project requirements were largely met with standard GCF circuit configuration as was the intended goal. Illustrated in Fig. 5 is the GCF configuration used during the primary mission phase following touchdown.

Acknowledgments

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Table 1. High-speed data block composition

Subdivision	22-bit Error polynomial		33-bit Error polynomial	
	Word	Bits	Word	Bits
Header	1 thru 7 (16 bits each)	112	1 thru 7 (16 bits each)	112
	8	8	8	8
Text	8 (Bit 9) thru 73 (Bit 8)	1040	8 (Bit 9) thru 73 (Bit 12)	1044
Ending	73 (Bit 9) thru 75 (Bit 16)	40	73 (Bit 13) thru 75 (Bit 16)	36
Totals	75	1200	75	1200

Table 2. High-speed filler block composition

Subdivision	22-bit Error polynomial		33-bit Error polynomial	
	Word	Bits	Word	Bits
Header	1 thru 3 (16 bits each)	48	1 thru 3 (16 bits each)	48
Text	4 (Bit 1) thru 73 (Bit 8)	1112	4 (Bit 1) thru 73 (Bit 12)	1116
Ending	73 (Bit 9) thru 75 (Bit 16)	40	73 (Bit 13) thru 75 (Bit 16)	36
Totals	75	1200	75	1200

Table 3. Wideband data block composition

Subdivision	Word	Bits
Header	1 thru 7 (16 bits each)	112
	8	8
Text	8 (Bit 9) thru 298 (Bit 12)	4644
Ending	298 (Bit 13) thru 300 (Bit 16)	36
Totals	300	4800

Table 4. Wideband filler block composition

Subdivision	Word	Bits
Header	1 thru 3 (16 bits each)	48
Text	4 (Bit 1) thru 298 (Bit 13)	4716
Ending	298 (Bit 13) thru 300 (Bit 16)	36
Totals	300	4800

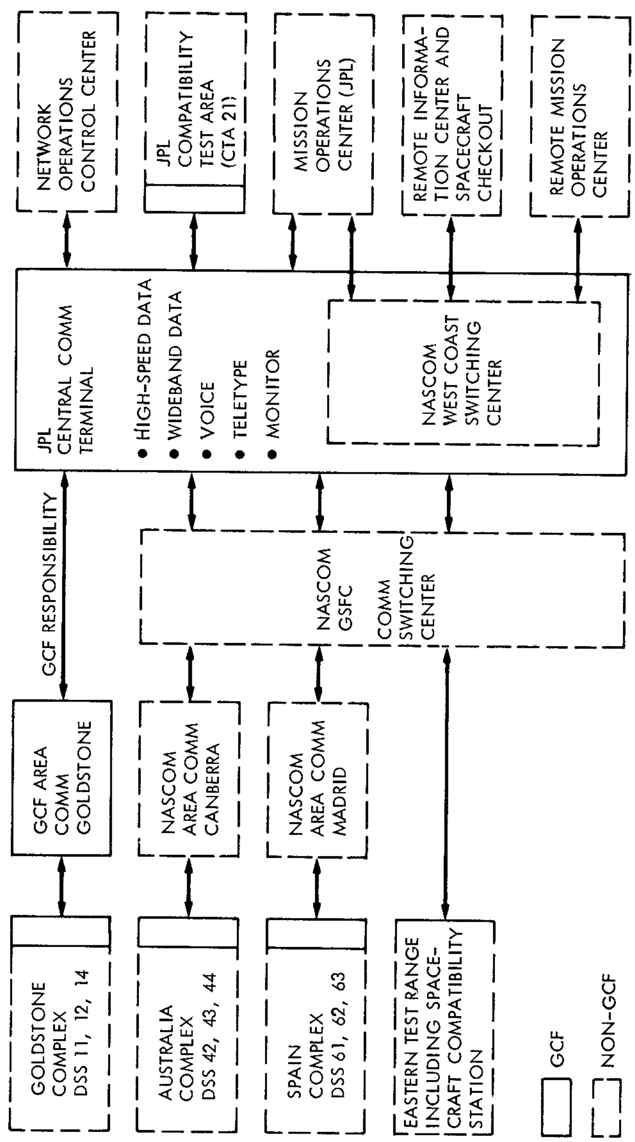


Fig. 1. GCF configuration

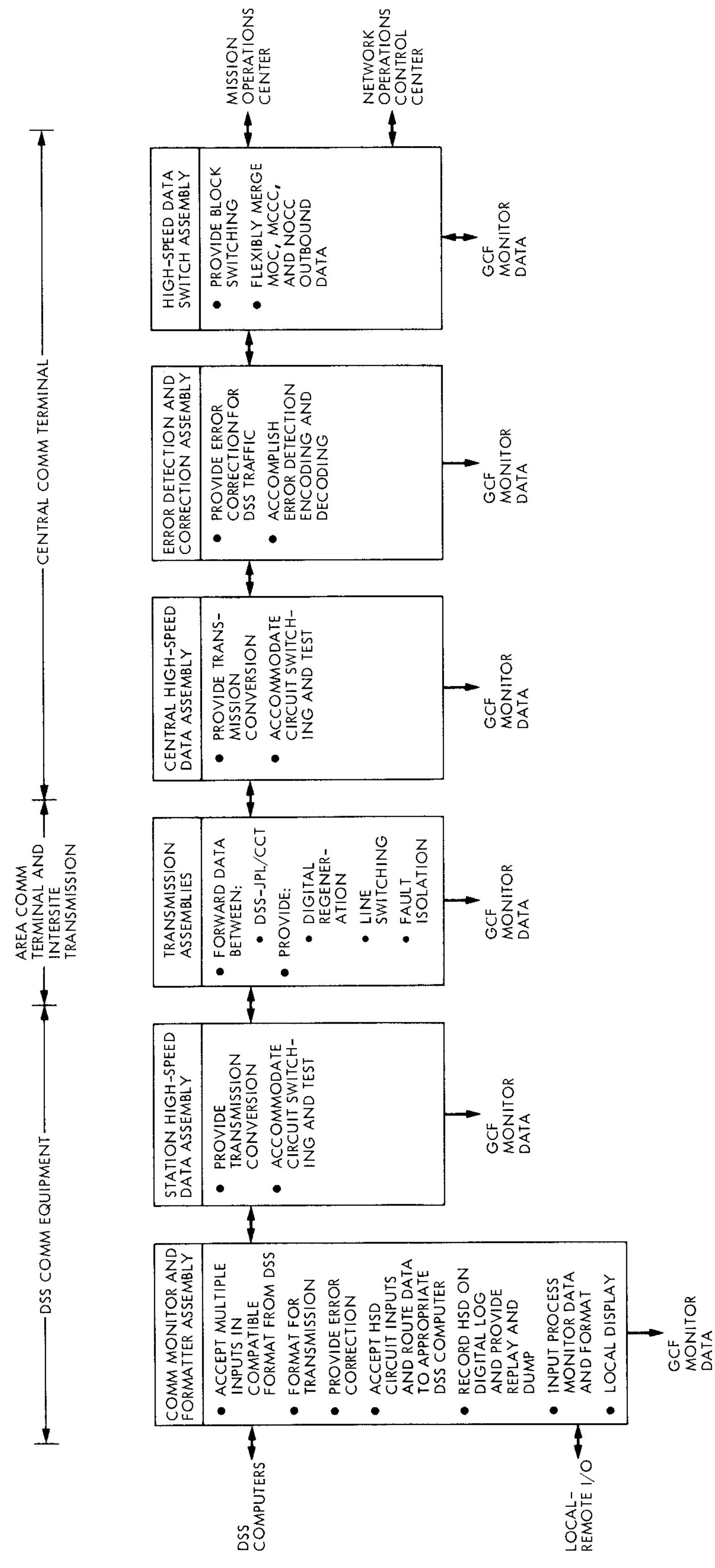


Fig. 2. GCF High-Speed Data Subsystem functional capabilities

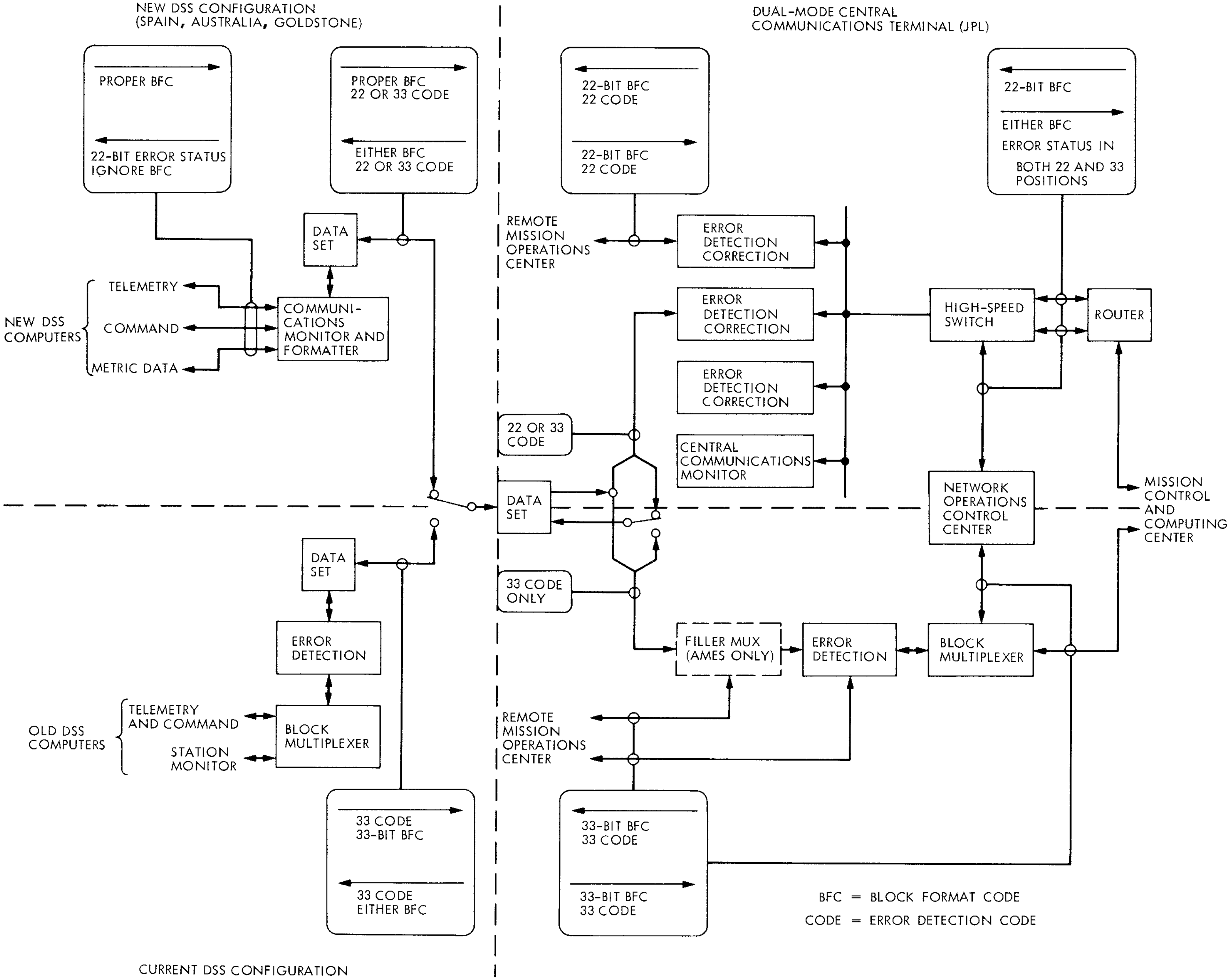


Fig. 3. GCF High-Speed Data Subsystem configuration and interfaces (CY 1977 and 1978)

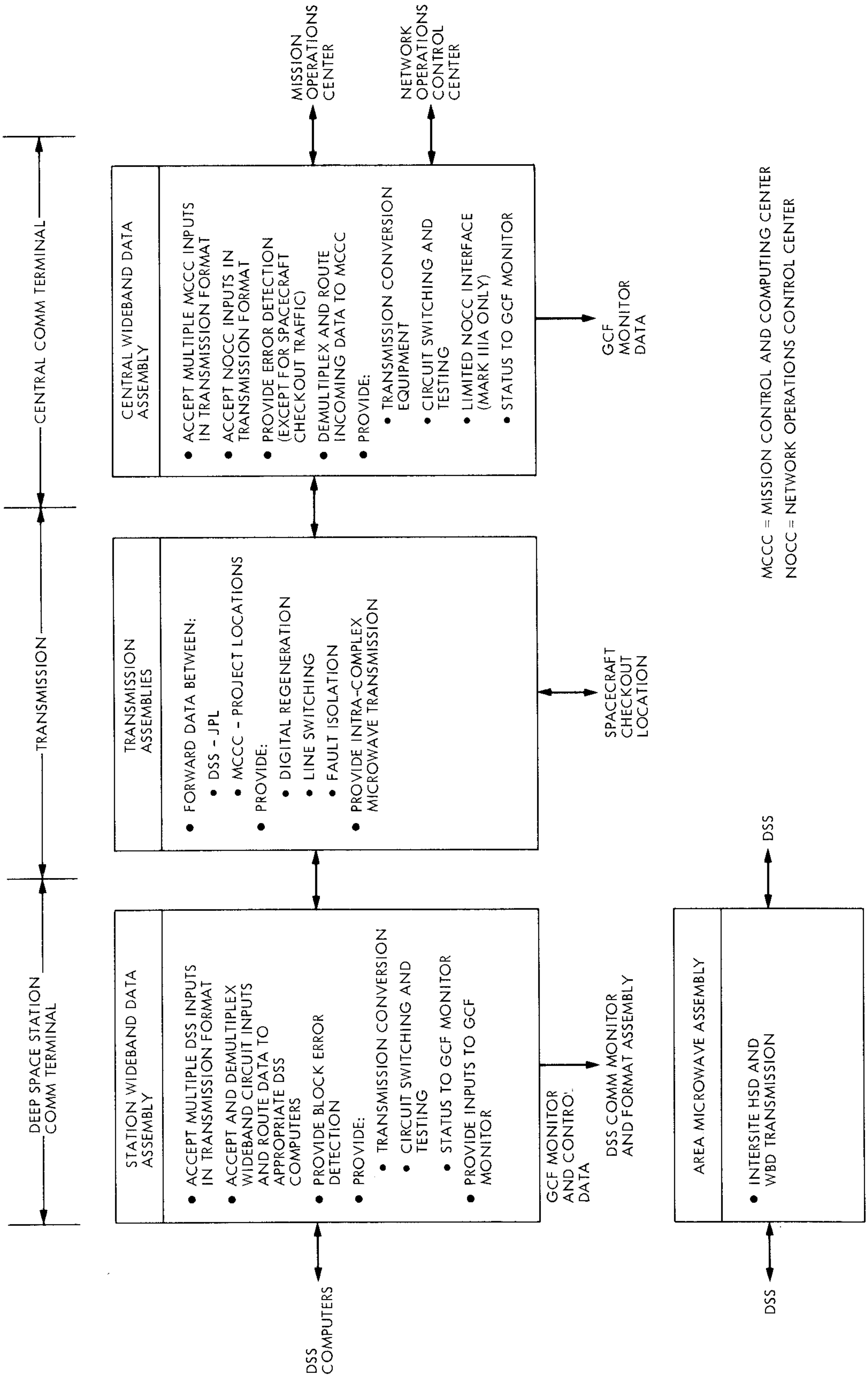
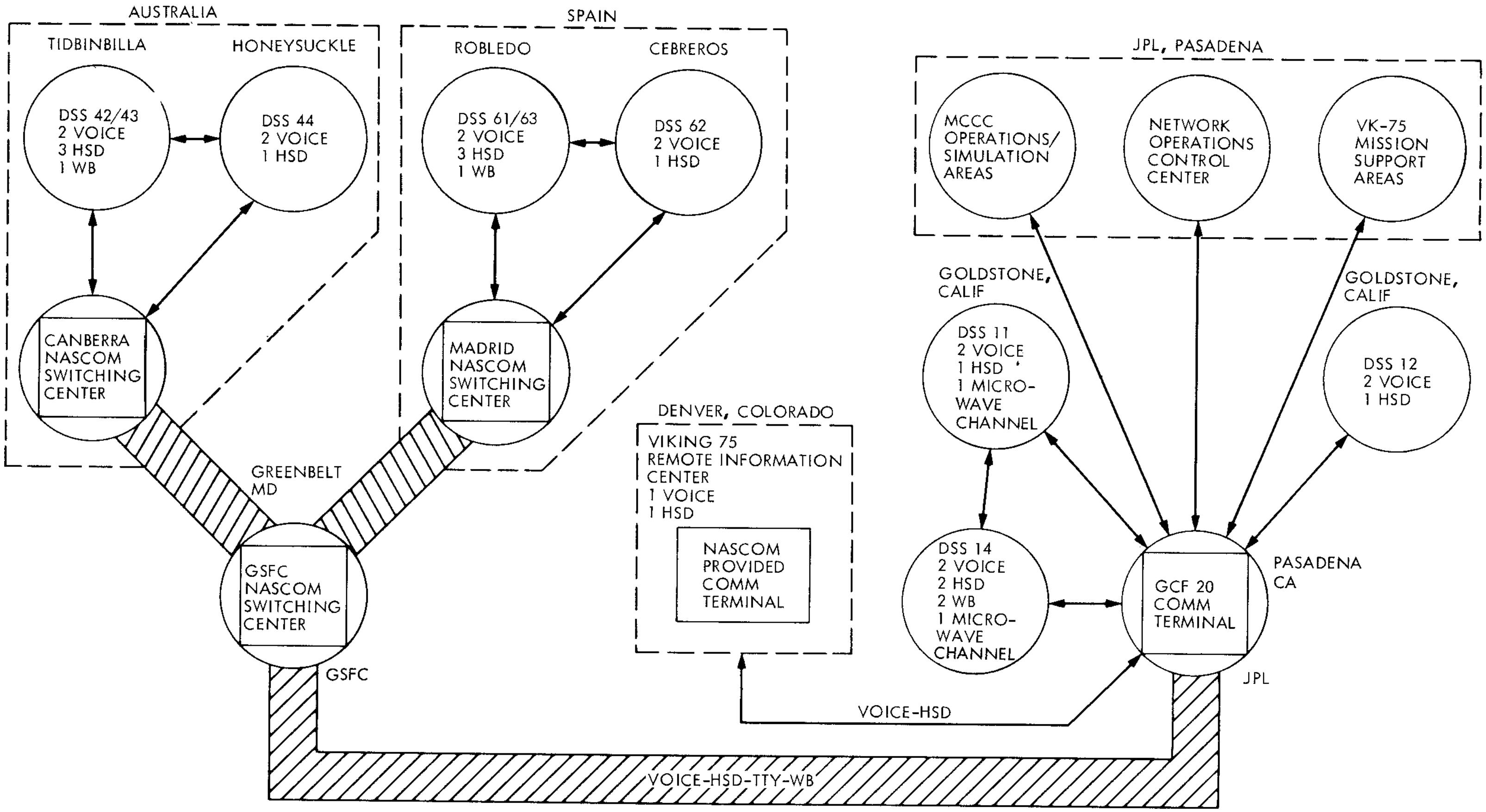


Fig. 4. GCF Wideband Subsystem



HSD = HIGH-SPEED DATA
MCCC = MISSION CONTROL AND COMPUTING CENTER
TTY = TELETYPE
WB = WIDEBAND

Fig. 5. DSN support locations and GCF–NASCOM circuit requirements for Viking 1975